PANDAS DATA STRUCTURES

Pandas Library

- Pandas is a Python library for data manipulation and analysis.
- It allows exploring, cleaning, and processing tabular data.
- It provides two ways for storing data;
  - Series, which is one dimensional data structure
  - Data Frame, which is two dimensional data structure

DataFrame

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843
5	Apple Cinnamon Cheerios	110	2	25	29.509541
6	Apple Jacks	110	2	25	33.174094
7	Basic 4	130	3	25	37.038562
8	Bran Chex	90	2	25	49.120253
9	Bran Flakes	90	3	25	53.313813

```
0     70
1    120
2     70
3     50
4    110
5    110
6    110
7    130
8     90
9     90
Name: calories, dtype: int64
```

Series

Pandas vs NumPy

NumPy	Pandas
NumPy and Pandas are both Python libraries for Data Science	
It is used for scientific computing	It is used for data manipulation such as storing, exploring, cleaning, and processing the data
It provides NumPy arrays which can be multidimensional	It provides two data structures; • Series (one dimensional) • Data frames (two dimensional)
We use Pandas for data manipulation and NumPy for Mathematical Computations	
Since Pandas Series and Data Frames can be thought of as one and two dimensional NumPy arrays respectively, we can apply NumPy mathematical functions on them as well	

Data Structures in Pandas

- Pandas has two main data structures;
  - DataFrame, which is two dimensional
  - Series, which is one dimensional

DataFrame

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843
5	Apple Cinnamon Cheerios	110	2	25	29.509541
6	Apple Jacks	110	2	25	33.174094
7	Basic 4	130	3	25	37.038562
8	Bran Chex	90	2	25	49.120253
9	Bran Flakes	90	3	25	53.313813

Series

```
0     70
1    120
2     70
3     50
4    110
5    110
6    110
7    130
8     90
9     90
Name: calories, dtype: int64
```

What is Pandas DataFrame

- Pandas provides a two dimensional data structure called DataFrame.
- A row is represented by row labels, also called index, which may be numerical or strings.
- A column is represented by column labels which may be numerical or strings.
- Following DataFrame contains 10 rows (0-9) and and 5 columns (name, calories, protein, vitamins, rating)

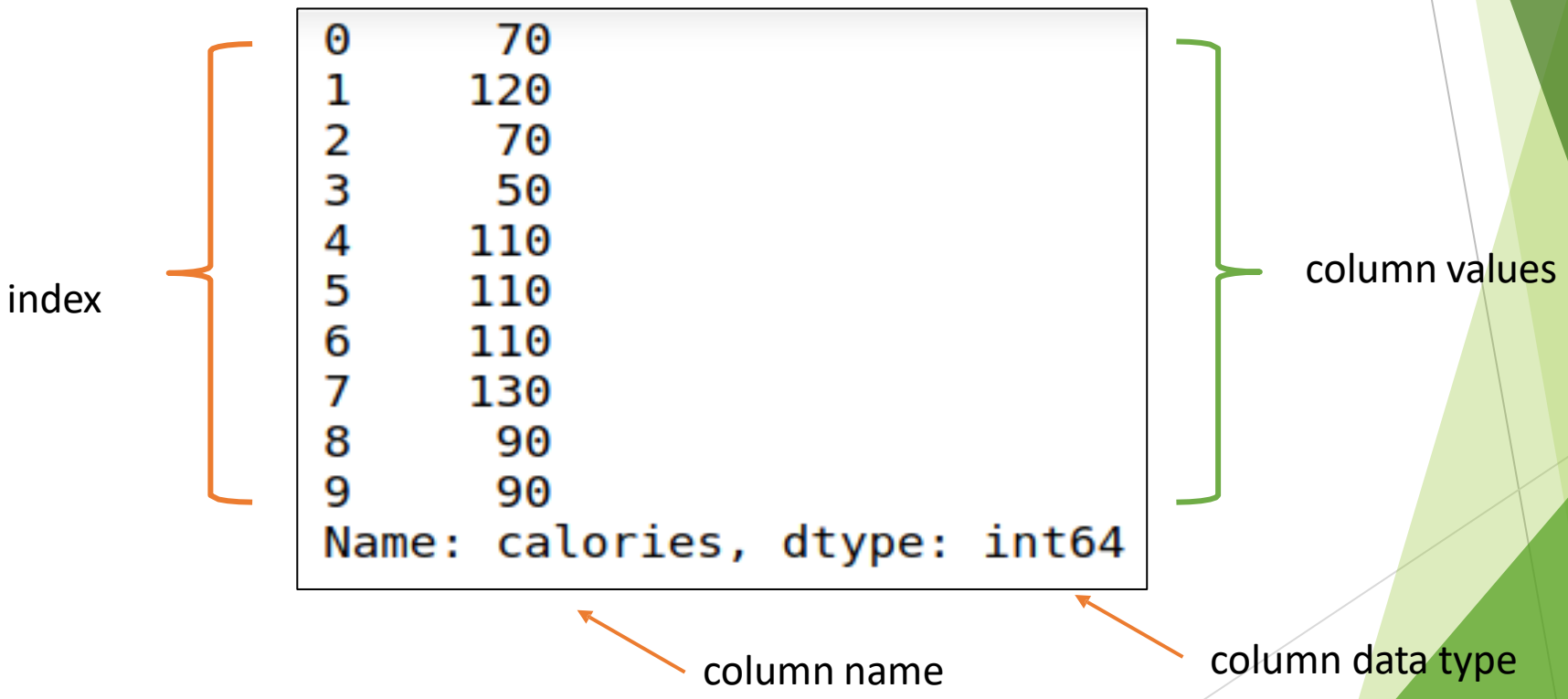
column labels

index

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843
5	Apple Cinnamon Cheerios	110	2	25	29.509541
6	Apple Jacks	110	2	25	33.174094
7	Basic 4	130	3	25	37.038562
8	Bran Chex	90	2	25	49.120253
9	Bran Flakes	90	3	25	53.313813

What is Pandas Series

- A Series in Pandas is a one dimensional data structure.
- It consists of a single row or column.
- Following Series contains 10 rows (0-9) and and 1 column called calories.



DataFrame and Series

- A Pandas DataFrame is just a collection of one or more Series.
- The Series in the previous example was extracted from the DataFrame.

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843
5	Apple Cinnamon Cheerios	110	2	25	29.509541
6	Apple Jacks	110	2	25	33.174094
7	Basic 4	130	3	25	37.038562
8	Bran Chex	90	2	25	49.120253
9	Bran Flakes	90	3	25	53.313813

DataFrame

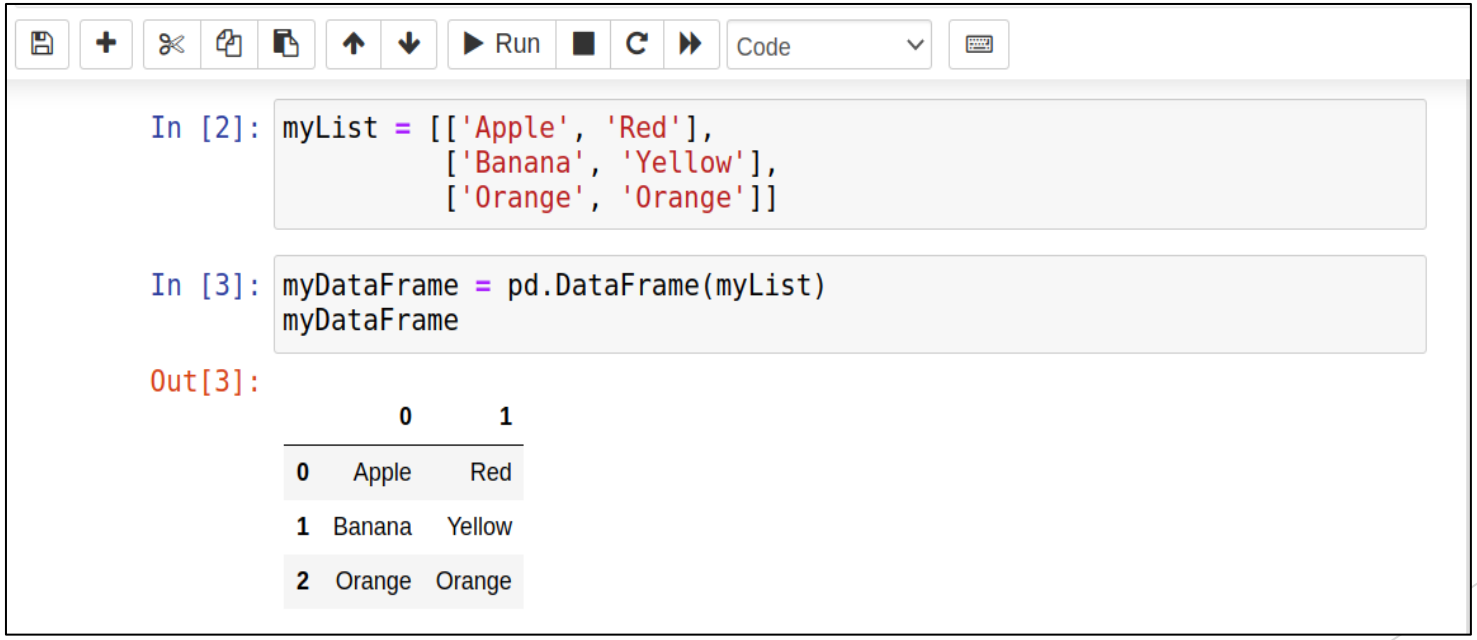
```
0     70
1    120
2     70
3     50
4    110
5    110
6    110
7    130
8     90
9     90
Name: calories, dtype: int64
```

Series

Identical

Creating a DataFrame Using Lists

- We can create a DataFrame using lists.
- We pass the list as an argument to the pandas.DataFrame() function which returns us a DataFrame.
- Pandas automatically assigns numerical row labels to each row of the DataFrame.
- Since, we did not provide column labels, Pandas automatically assigned numerical column labels to each column as well.



	0	1
0	Apple	Red
1	Banana	Yellow
2	Orange	Orange

Creating a DataFrame Using Lists

- Let's create another DataFrame using the same list, but this time with custom column labels.
- Pandas.DataFrame() takes another optional argument called 'columns' which takes a list of custom column names to be set as columns' labels.

```
In [2]: myList = [['Apple', 'Red'],
                  ['Banana', 'Yellow'],
                  ['Orange', 'Orange']]
```

```
In [4]: myDataFrame = pd.DataFrame(myList, columns=['Fruit', 'Color'])
        myDataFrame
```

Out[4]:

	Fruit	Color
0	Apple	Red
1	Banana	Yellow
2	Orange	Orange

Creating a DataFrame Using Lists

- As we know that a NumPy Array is similar to a Python list with added functionality, we can also convert a NumPy Array to a DataFrame using the same method.

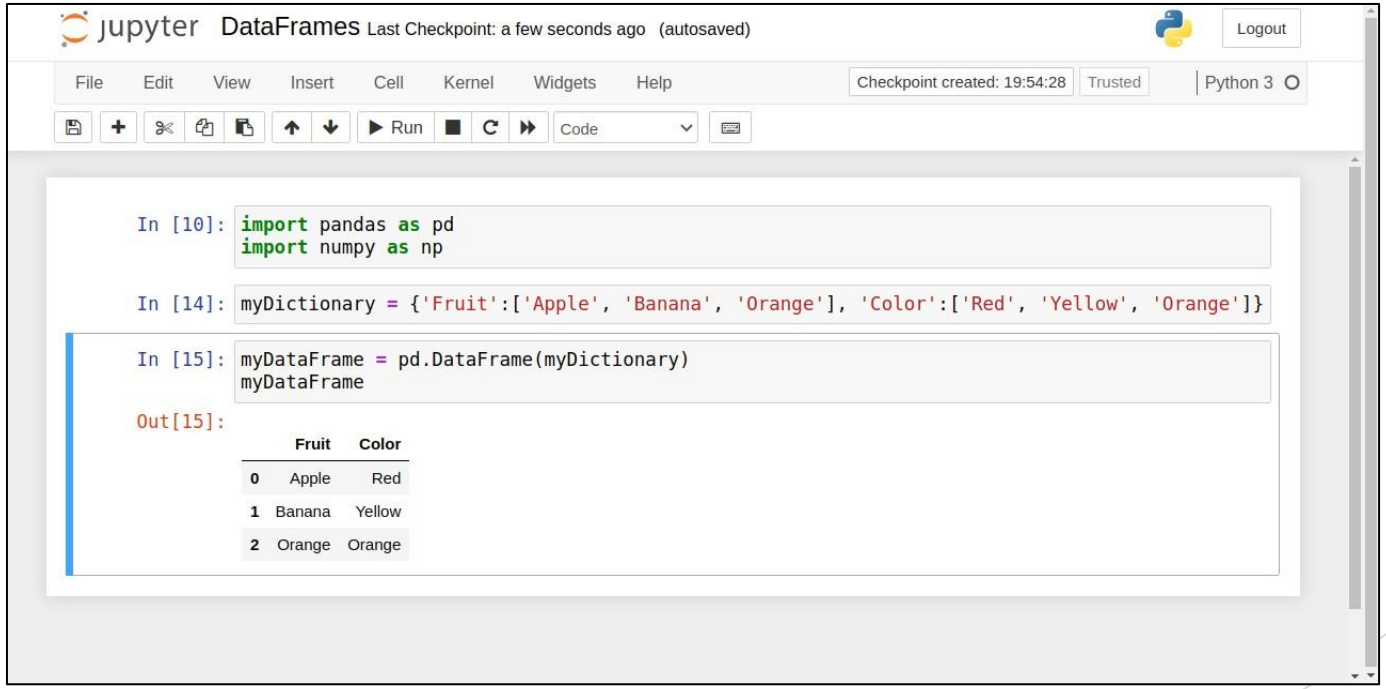
```
In [9]: myList = np.array([[0, 1],
                           [2, 3],
                           [4, 5]])

In [10]: myDataFrame = pd.DataFrame(myList, columns=['even', 'odd'])
         myDataFrame
```

Out[10]:

	even	odd
0	0	1
1	2	3
2	4	5

Creating a DataFrame Using Dictionary

- We can also pass a dictionary to the pandas.DataFrame() function to create a DataFrame.
- Each key of the array should have a list of one or more values associated with it.
- The keys of the dictionary become column labels.
- Pandas automatically assigns numerical row labels to each row of the DataFrame.



Loading csv File as a DataFrame

- We can also load a csv (comma separated values) file as a DataFrame in Pandas using the pandas.read_csv() function.
- Each value of the first row of the csv file becomes a column label.
- Pandas automatically assigns numerical row labels to each row of the DataFrame.

```
In [11]: df = pd.read_csv('cereals.csv')
         df
```

Out[11]:

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843
5	Apple Cinnamon Cheerios	110	2	25	29.509541
6	Apple Jacks	110	2	25	33.174094
7	Basic 4	130	3	25	37.038562
8	Bran Chex	90	2	25	49.120253
9	Bran Flakes	90	3	25	53.313813

Changing the Index Column

- We can set one of the existing columns as the new index column of the DataFrame using .set_index() function.

```
In [13]: df
```

Out[13]:

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843

```
In [14]: df.set_index('name')
```

Out[14]:

	calories	protein	vitamins	rating
name				
100% Bran	70	4	25	68.402973
100% Natural Bran	120	3	0	33.983679
All-Bran	70	4	25	59.425505
All-Bran with Extra Fiber	50	4	25	93.704912
Almond Delight	110	2	25	34.384843

Inplace

- Remember that most of the functions in Pandas do not change the original DataFrame.
- In the previous section we changed the index column of our DataFrame. If we print our DataFrame again, we see that the original DataFrame is unchanged.

```
In [15]: df
```

Out[15]:

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843

Inplace

- We can use the inplace argument to make changes to the original DataFrame.
- In the following example we use the .set_index() function to change the index of our DataFrame, and set inplace = True.
- As shown in the figure, our original DataFrame has been changed.

```
In [16]: df.set_index('name', inplace=True)

In [17]: df
```

Out[17]:

name	calories	protein	vitamins	rating
100% Bran	70	4	25	68.402973
100% Natural Bran	120	3	0	33.983679
All-Bran	70	4	25	59.425505
All-Bran with Extra Fiber	50	4	25	93.704912
Almond Delight	110	2	25	34.384843

Examining the Data

head()

- head() function gives us the **first** 5 rows of the DataFrame/Series by default.
- To get more rows, we can pass the desired number as an argument to the head() function.

```
In [20]: df.head(7)
```

Out[20]:

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843
5	Apple Cinnamon Cheerios	110	2	25	29.509541
6	Apple Jacks	110	2	25	33.174094

Examining the Data

tail()

- tail() function gives us the **last** 5 rows of the DataFrame/Series by default.

- To get more rows, we can pass the desired number as an argument to the tail() function.

```
In [22]: df.tail(7)
```

Out[22]:

	name	calories	protein	vitamins	rating
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843
5	Apple Cinnamon Cheerios	110	2	25	29.509541
6	Apple Jacks	110	2	25	33.174094
7	Basic 4	130	3	25	37.038562
8	Bran Chex	90	2	25	49.120253
9	Bran Flakes	90	3	25	53.313813

Statistical Summary

- We can use the describe() function to get a quick statistical summary of each column of the DataFrame.

```
In [25]: df.describe()
```

Out[25]:

	calories	protein	vitamins	rating
count	5.000000	5.000000	5.00000	5.000000
mean	84.000000	3.400000	20.00000	57.980382
std	29.664794	0.894427	11.18034	25.097570
min	50.000000	2.000000	0.00000	33.983679
25%	70.000000	3.000000	25.00000	34.384843
50%	70.000000	4.000000	25.00000	59.425505
75%	110.000000	4.000000	25.00000	68.402973
max	120.000000	4.000000	25.00000	93.704912

[ ] Operator for Row Slicing

- We can use the brackets ([ ]) operator to slice rows of the DataFrame.
- We pass a start index (inclusive) and an end index (exclusive) to the bracket operator ([ ]) to slice the rows of the DataFrame.

```
In [26]: df[1:4]
```

Out[26]:

	name	calories	protein	vitamins	rating
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912

[ ] Operator for Row Slicing

- Remember that [ ] operator works on row position and not row labels.
- For example, in the following case row labels are strings. But we pass positions of the rows that we want to slice.

```
In [30]: df
```

Out[30]:

name	calories	protein	vitamins	rating
100% Bran	70	4	25	68.402973
100% Natural Bran	120	3	0	33.983679
All-Bran	70	4	25	59.425505
All-Bran with Extra Fiber	50	4	25	93.704912
Almond Delight	110	2	25	34.384843

```
In [31]: df[1:4]
```

Out[31]:

name	calories	protein	vitamins	rating
100% Natural Bran	120	3	0	33.983679
All-Bran	70	4	25	59.425505
All-Bran with Extra Fiber	50	4	25	93.704912

[ ] Operator for Column Indexing

- We can also use the brackets ([ ]) operator to index column of the DataFrame.
- Indexing a single column returns a Series.
- Indexing a list of columns returns a DataFrame.
- Remember that for indexing columns, we pass their labels to the [ ] operator and not their positions.

```
In [34]: df[['name', 'rating']]
```

Out[34]:

	name	rating
0	100% Bran	68.402973
1	100% Natural Bran	33.983679
2	All-Bran	59.425505
3	All-Bran with Extra Fiber	93.704912
4	Almond Delight	34.384843

Boolean List

- We can also pass a list of booleans to the [ ] operator.
- We get all the rows of the DataFrame for which the corresponding element in the list is True.
- Rows of the DataFrame for which the corresponding element in the list is False are ignored.
- Note: Original DataFrame remains unchanged.

```
In [71]: df
```

Out[71]:

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843

```
In [75]: thirdRow = [False, False, True, False, False]
         df[thirdRow]
```

Out[75]:

	name	calories	protein	vitamins	rating
2	All-Bran	70	4	25	59.425505

Filtering Rows

- We can also use the [ ] operator to apply conditions on one or more columns of the DataFrame.
- Rows of the DataFrame which satisfy those conditions are filtered out.

```
In [36]: condition = df['calories'] > 70
         df[condition]
```

Out[36]:

	name	calories	protein	vitamins	rating
1	100% Natural Bran	120	3	0	33.983679
4	Almond Delight	110	2	25	34.384843

```
In [37]: df[ df['calories'] > 70]
```

Out[37]:

	name	calories	protein	vitamins	rating
1	100% Natural Bran	120	3	0	33.983679
4	Almond Delight	110	2	25	34.384843

Filtering Rows

and (&)

- We can also group conditions using the and operator.
- Symbol for and in pandas is &. It works the same way as and in Python.
- Note: Each condition should be in parentheses.

```
In [38]: df[ (df['calories'] > 70) & (df['protein'] < 4)]
```

Out[38]:

	name	calories	protein	vitamins	rating
1	100% Natural Bran	120	3	0	33.983679
4	Almond Delight	110	2	25	34.384843

Filtering Rows

or (|)

- We can also group conditions using the or operator.
- Symbol for and in pandas is | It works the same way as or in Python.
- Note: Each condition should be in parentheses.

```
In [39]: df[ (df['calories'] > 70) | (df['protein'] > 3)]
```

Out[39]:

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843

loc

Indexing

- loc is used to index/slice a group of rows and columns based on their labels.
- The first argument is the row label and the second argument is the column label.
- In the following example we index the first row and the first column.

```
In [79]: df
```

Out[79]:

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843

```
In [88]: df.loc[0, 'name']
Out[88]: '100% Bran'
```

loc

Indexing

- If we pass a list of row and column labels, we get a DataFrame.
- In the following example, we index first row and first column, but we pass the labels as lists. We get a DataFrame.

```
In [79]: df
```

Out[79]:

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843

```
In [89]: df.loc[[0], ['name']]
```

Out[89]:

	name
0	100% Bran

loc

Slicing

- We can also slice rows and/or columns using the loc method.
- Both the start and stop index of a slice with loc are inclusive.
- In the following example, we slice the first 5 rows and the first 3 columns of the DataFrame. The result is a DataFrame.

```
In [41]: df
```

Out[41]:

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843
5	Apple Cinnamon Cheerios	110	2	25	29.509541
6	Apple Jacks	110	2	25	33.174094
7	Basic 4	130	3	25	37.038562
8	Bran Chex	90	2	25	49.120253
9	Bran Flakes	90	3	25	53.313813

```
In [42]: df.loc[0:4, 'name':'protein']
```

Out[42]:

	name	calories	protein
0	100% Bran	70	4
1	100% Natural Bran	120	3
2	All-Bran	70	4
3	All-Bran with Extra Fiber	50	4
4	Almond Delight	110	2

loc

Indexing and Slicing

- We can index and slice simultaneously as well.
- In the following example we index rows and slice columns. The opposite is also possible.

```
In [43]: df.loc[[5, 8], 'name':'protein']
```

Out[43]:

	name	calories	protein
5	Apple Cinnamon Cheerios	110	2
8	Bran Chex	90	2

iloc

Indexing

- iloc is used to index/slice a group of rows and columns.
- Iloc takes row and column positions as arguments and not their labels.
- The first argument is the row position and the second argument is the column position.
- In the following example we index the 10th row and the third column. The result is a Series.

```
In [41]: df
```

Out[41]:

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843
5	Apple Cinnamon Cheerios	110	2	25	29.509541
6	Apple Jacks	110	2	25	33.174094
7	Basic 4	130	3	25	37.038562
8	Bran Chex	90	2	25	49.120253
9	Bran Flakes	90	3	25	53.313813

```
In [44]: df.iloc[9, 2]

Out[44]: 3
```

iloc

Indexing

- If we pass a lsit of row and column positions, we get a DataFrame.
- In the following example, we index 10th row and third column, but we pass the positions as lists. We get a DataFrame.

```
In [45]: df.iloc[[9], [2]]
```

Out[45]:

	protein
9	3

iloc

Slicing

- We can also slice rows and/or columns using the iloc method.
- We provide row and column positions for slicing using iloc.
- The start index of a slice with iloc is inclusive. However, the end index is exclusive.
- In the following example, we slice the first 5 rows and the first 3 columns of the DataFrame. The result is a DataFrame.

```
In [46]: df.iloc[0:5, 0:3]
```

Out[46]:

	name	calories	protein
0	100% Bran	70	4
1	100% Natural Bran	120	3
2	All-Bran	70	4
3	All-Bran with Extra Fiber	50	4
4	Almond Delight	110	2

iloc

Indexing and Slicing

- We can index and slice simultaneously as well.
- In the following example we index rows and slice columns. The opposite is also possible.

```
In [47]: df.iloc[[0, 2, 4], 0:3]
```

Out[47]:

	name	calories	protein
0	100% Bran	70	4
2	All-Bran	70	4
4	Almond Delight	110	2

Adding and Deleting Rows and Columns

Adding Rows

- We can add more rows to our DataFrame using the loc method.
- If the row label does not exist, a new row with the specified label will be added at the end of the row.

```
In [24]: df
```

Out[24]:

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843

```
In [68]: df.loc[6] = ['Trix', 110, 1, 25, 27.753301]
         df
```

Out[68]:

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843
6	Trix	110	1	25	27.753301

Adding and Deleting Rows and Columns

Deleting Rows

- We can delete rows from the DataFrame using drop() function by specifying axis=0 for rows.
- Provide the labels of the rows to be deleted as argument to the drop() function.
- Don’t forget to use inplace=True, otherwise the original DataFrame will remain unchanged.

```
In [69]: df.drop(2, axis=0, inplace=True)

In [70]: df
```

Out[70]:

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843
6	Trix	110	1	25	27.753301

Adding and Deleting Rows and Columns

Adding Columns

- To add a column to the DataFrame, we use the same notation as adding a key, value pair to a dictionary.
- Instead of the key, we provide column name in the square brackets, and then provide a list of values for that column.
- If no column with the given name exists, a new column with the specified name and values will be added to the DataFrame.

```
In [71]: df['My Column'] = ['A', 'B', 'C', 'D', 'E']
         df
```

Out[71]:

	name	calories	protein	vitamins	rating	My Column
0	100% Bran	70	4	25	68.402973	A
1	100% Natural Bran	120	3	0	33.983679	B
3	All-Bran with Extra Fiber	50	4	25	93.704912	C
4	Almond Delight	110	2	25	34.384843	D
6	Trix	110	1	25	27.753301	E

Adding and Deleting Rows and Columns

Deleting Columns

- We can also delete columns of the DataFrame using drop() function by specifying axis=1 for columns.
- Provide the column names to be deleted as argument to the drop() function.
- Don’t forget to use inplace=True, otherwise the original DataFrame will remain unchanged.

```
In [72]: df.drop('My Column', axis=1, inplace=True)

In [73]: df
```

Out[73]:

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843
6	Trix	110	1	25	27.753301

Sorting Values

Ascending

- We can sort the values of a DataFrame with respect to a column using the sort_values() function, which sorts the values in ascending order by default.
- If the values of the column are alphabets, the are sorted alphabetically.
- If the values of the column are numbers, they are sorted numerically.

```
In [74]: df.sort_values(by='calories')
```

Out[74]:

	name	calories	protein	vitamins	rating
3	All-Bran with Extra Fiber	50	4	25	93.704912
0	100% Bran	70	4	25	68.402973
4	Almond Delight	110	2	25	34.384843
6	Trix	110	1	25	27.753301
1	100% Natural Bran	120	3	0	33.983679

Sorting Values

Descending

- To sort the values in descending order, we set ascending = False in the sort_values() function.

```
In [75]: df.sort_values(by='calories', ascending=False)
```

Out[75]:

	name	calories	protein	vitamins	rating
1	100% Natural Bran	120	3	0	33.983679
4	Almond Delight	110	2	25	34.384843
6	Trix	110	1	25	27.753301
0	100% Bran	70	4	25	68.402973
3	All-Bran with Extra Fiber	50	4	25	93.704912

Exporting and Saving Pandas DataFrame

- To export a DataFrame as a csv file, use to_csv() function.
- If a file with the specified filename exists, it will be modified. Otherwise, a new file with the specified filename will be created.
- If you do not want to store index column in the csv file, you can set index_label=False in the to_csv() function.

```
In [76]: df.to_csv('myFile.csv', index_label=False)

In [77]: newDf = pd.read_csv('myFile.csv')
         newDf
```

Out[77]:

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843
6	Trix	110	1	25	27.753301

Concatenating DataFrames

- We can concatenate two or more DataFrames together using pandas.concat() function.

First Data Frame

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843

Second Data Frame

	name	calories	protein	vitamins	rating
5	Apple Cinnamon Cheerios	110	2	25	29.509541
6	Apple Jacks	110	2	25	33.174094
7	Basic 4	130	3	25	37.038562
8	Bran Chex	90	2	25	49.120253
9	Bran Flakes	90	3	25	53.313813
10	Cap'n'Crunch	120	1	25	18.042851

Resultant Data Frame

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505
3	All-Bran with Extra Fiber	50	4	25	93.704912
4	Almond Delight	110	2	25	34.384843
5	Apple Cinnamon Cheerios	110	2	25	29.509541
6	Apple Jacks	110	2	25	33.174094
7	Basic 4	130	3	25	37.038562
8	Bran Chex	90	2	25	49.120253
9	Bran Flakes	90	3	25	53.313813
10	Cap'n'Crunch	120	1	25	18.042851

Concatenating DataFrames

- We can also concatenate two or more DataFrames side-by-side each other.

First Data Frame

	name	calories	protein	vitamins	rating
0	Apple Cinnamon Cheerios	110	2	25	29.509541
1	Apple Jacks	110	2	25	33.174094
2	Basic 4	130	3	25	37.038562

Second Data Frame

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505

	name	calories	protein	vitamins	rating	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973	Apple Cinnamon Cheerios	110	2	25	29.509541
1	100% Natural Bran	120	3	0	33.983679	Apple Jacks	110	2	25	33.174094
2	All-Bran	70	4	25	59.425505	Basic 4	130	3	25	37.038562

Resultant Data Frame

Concatenating DataFrames

- To join two or more DataFrames side-by-side, use axis = 1 in the pandas.concat() function.

```
In [26]: df
```

Out[26]:

	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973
1	100% Natural Bran	120	3	0	33.983679
2	All-Bran	70	4	25	59.425505

```
In [36]: df2
```

Out[36]:

	name	calories	protein	vitamins	rating
0	Apple Cinnamon Cheerios	110	2	25	29.509541
1	Apple Jacks	110	2	25	33.174094
2	Basic 4	130	3	25	37.038562

```
In [37]: pd.concat([df, df2], axis=1)
```

Out[37]:

	name	calories	protein	vitamins	rating	name	calories	protein	vitamins	rating
0	100% Bran	70	4	25	68.402973	Apple Cinnamon Cheerios	110	2	25	29.509541
1	100% Natural Bran	120	3	0	33.983679	Apple Jacks	110	2	25	33.174094
2	All-Bran	70	4	25	59.425505	Basic 4	130	3	25	37.038562

groupby()

- groupby() function is used to group DataFrame based on Series.
  - The DataFrame is splitted into groups.
  - An aggregate function is applied to each column of the splitted DataFrame.
  - Results are combined together.
- Consider the following DataFrame.

	Gender	Score
0	female	85
1	male	88
2	female	95
3	male	80

groupby()

- The ‘Gender’ column contains two values, male and female.
- Let’s split our DataFrame into two parts based on ‘Gender’ column;
  - First part will contain the rows where Gender = male
  - Second part will contain the rows where Gender = female

	Gender	Score
0	female	85
2	female	95

	Gender	Score
1	male	88
3	male	80

groupby()

- If we find the mean score of both the genders, this is what we get.

Gender	Score
female	90

Gender	Score
male	84

groupby()

- Let's combine the two results together. This is what we get.

Gender	Score
female	90
male	84

groupby()

- The groupby() function works exactly the same way, except that it makes things easier for us.
- In the given example, we group our DataFrame on the basis of 'Gender' column, and then apply the aggregate function mean() on it.

```
In [55]: df
```

Out[55]:

	Gender	Score
0	female	85
1	male	88
2	female	95
3	male	80

```
In [56]: df.groupby(x['Gender']).mean()
```

Out[56]:

	Score
Gender	
female	90
male	84

groupby()

- Note that aggregate functions are applied automatically on all the columns of the DataFrame except the one used to group the DataFrame.

```
In [72]: df
```

Out[72]:

	Gender	Math	English
0	female	85	80
1	male	88	88
2	female	95	92
3	male	80	95

```
In [73]: df.groupby(x['Gender']).mean()
```

Out[73]:

	Math	English
Gender		
female	90.0	86.0
male	84.0	91.5

groupby()

- The common aggregate functions are;
  - mean()
  - sum()
  - max()
  - min()
  - median()
  - count()
  - std() (standard deviation)